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(54) STRUT MOUNTING ARRANGEMENT FOR GAS TURBINE EXHAUST CASE

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F01D 9/06 (2006.01)

(52) **U.S. Cl.**
CPC . ***F01D 25/28*** (2013.01); *F01D 9/06* (2013.01); *F05D 2240/62* (2013.01); *F05D 2300/5021* (2013.01)
USPC **415/119**; 415/209.3; 415/209.4; 415/210.1

(58) **Field of Classification Search**
USPC 415/119, 133, 140, 209.3, 209.4, 210.1
See application file for complete search history.

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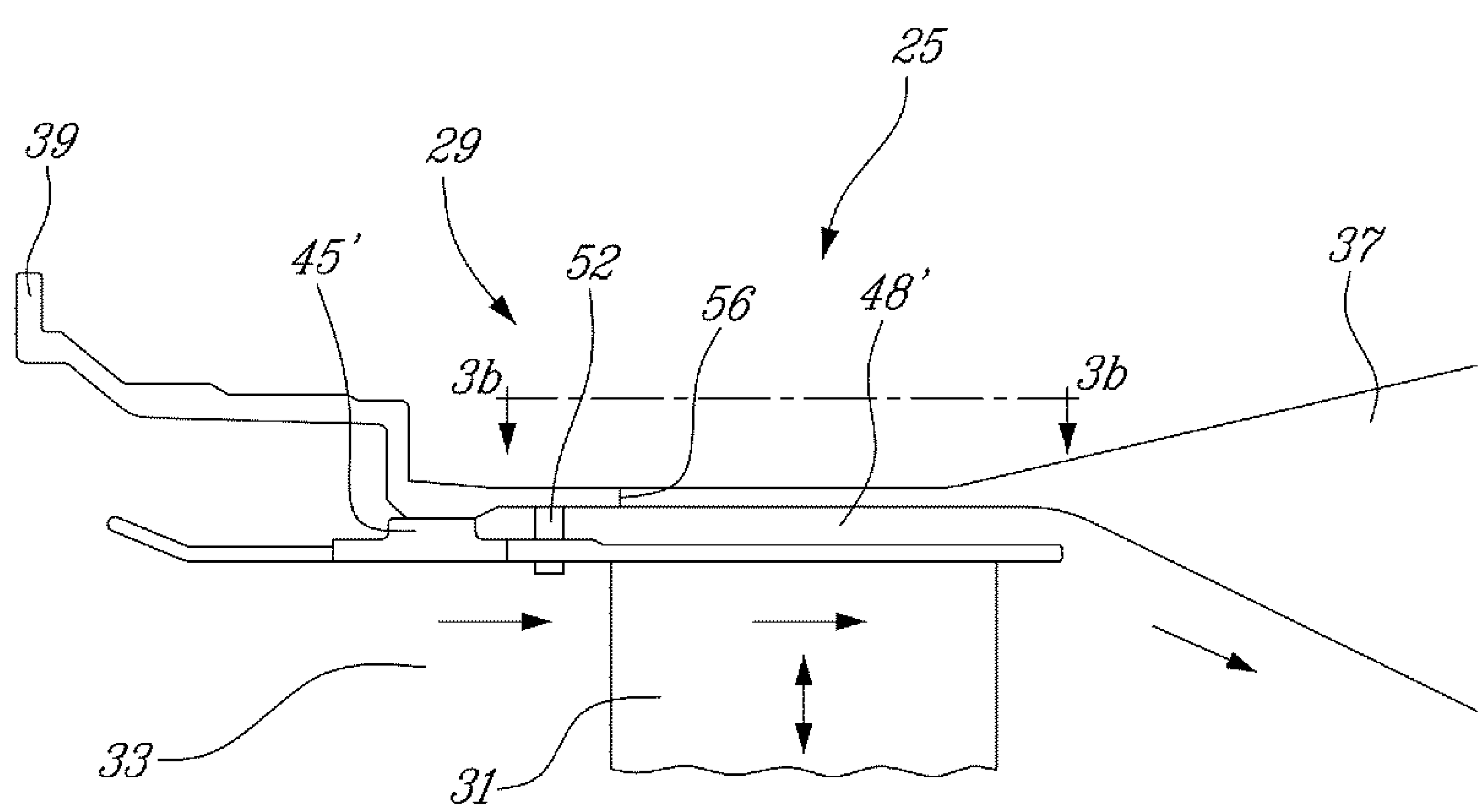
(57) **ABSTRACT**

A turbine exhaust case comprises inner and outer annular shrouds defining therebetween an annular hot gaspath. A circumferential array of exhaust struts extends across the gaspath. The exhaust struts are mounted at one radial end thereof on a flexible strut mounting structure. The flexible strut mounting structure is radially deflectable relative to the outer and inner shrouds to accommodate thermal expansion of the exhaust struts during engine operation.

11 Claims, 3 Drawing Sheets



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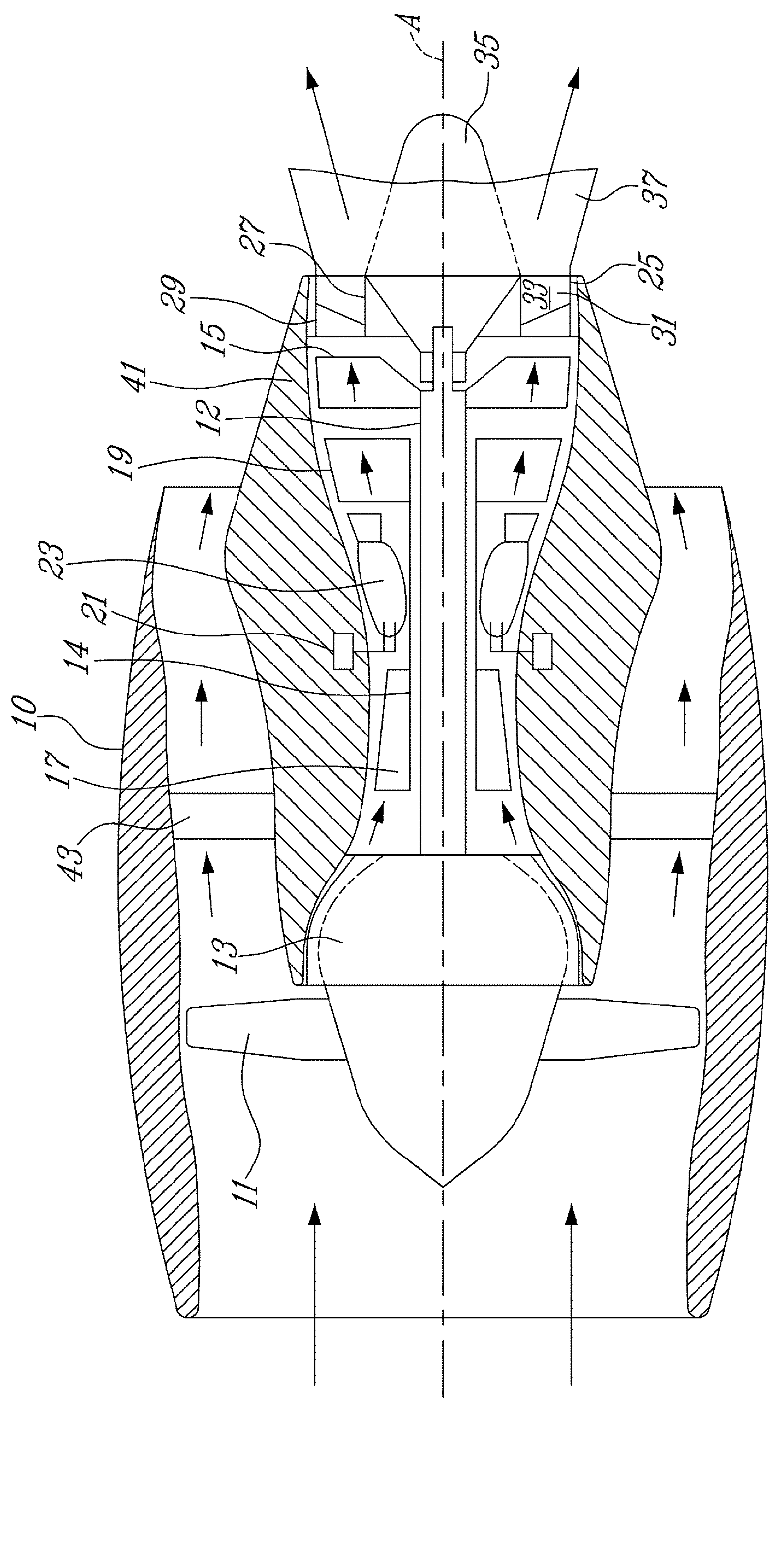

FIG-1

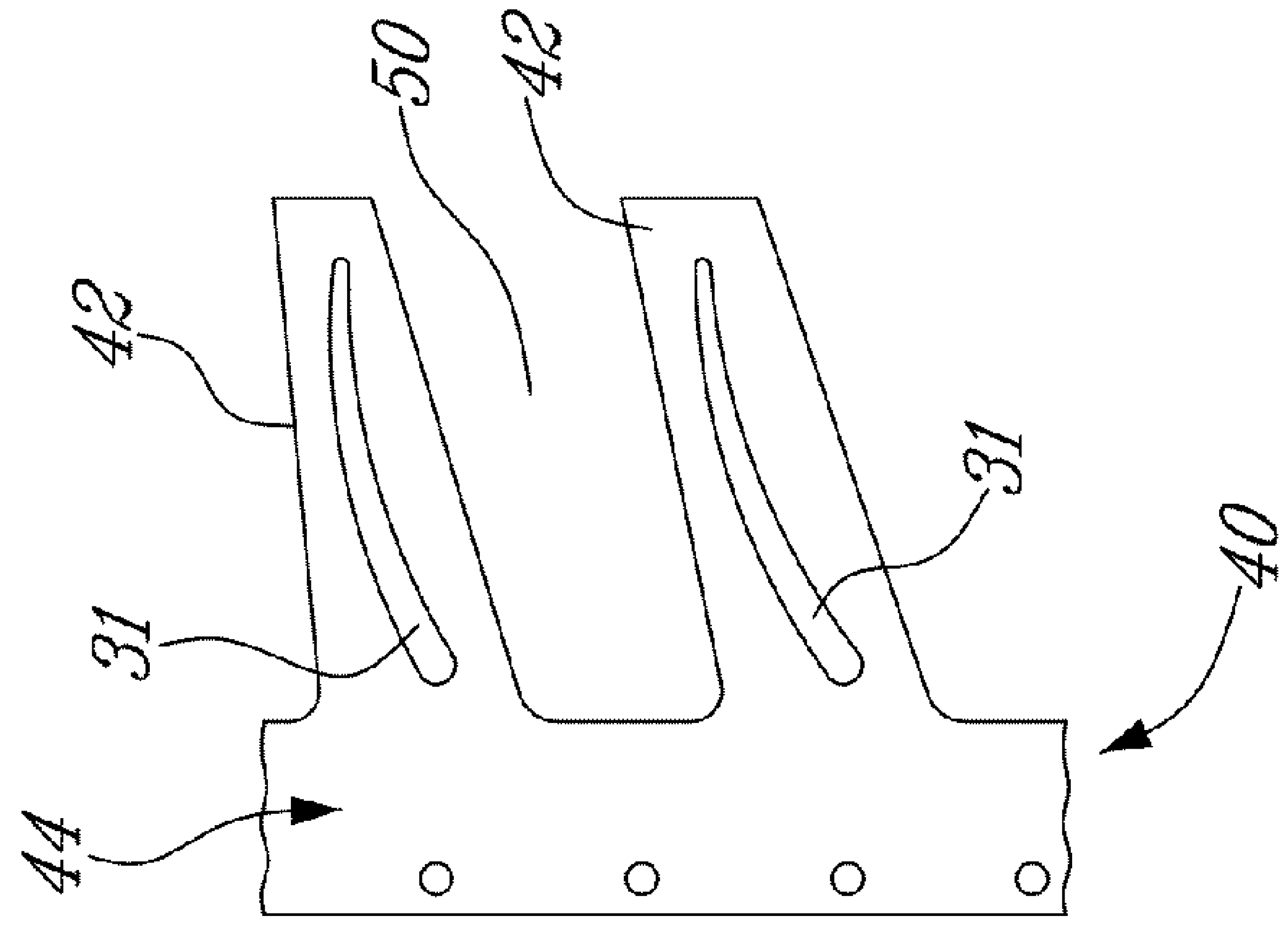

Fig-2b

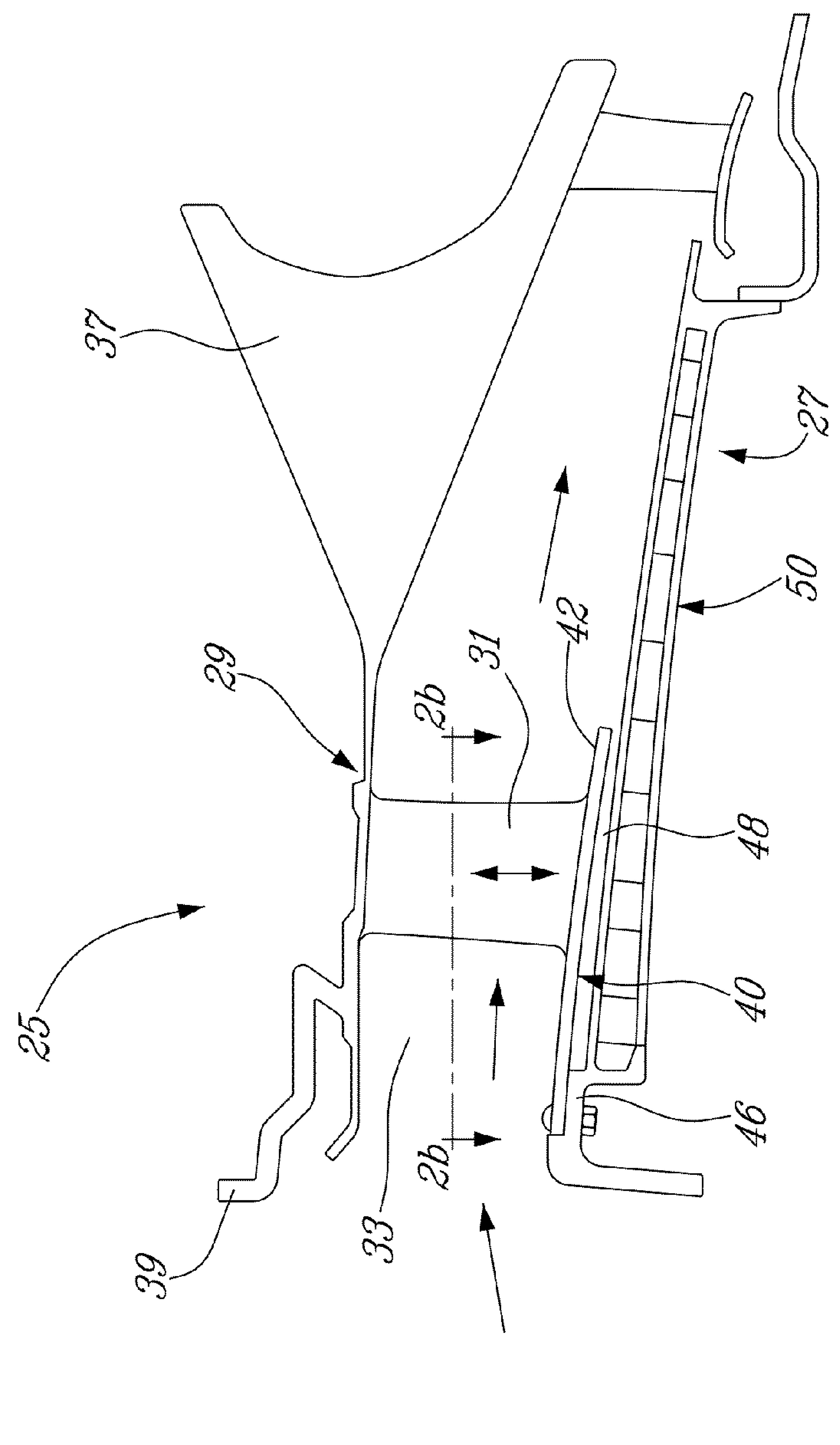

Fig-2a

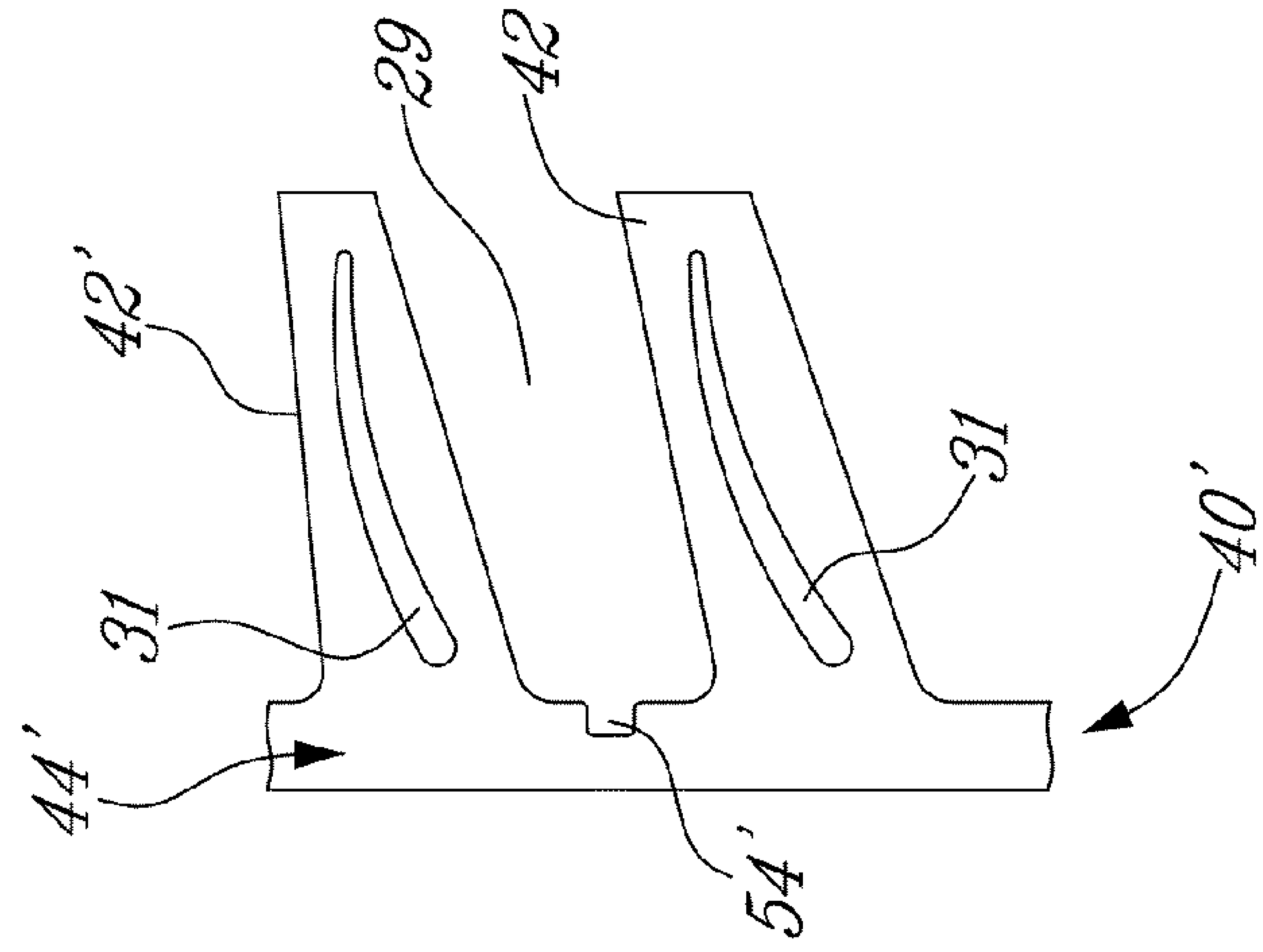

Fig-3b

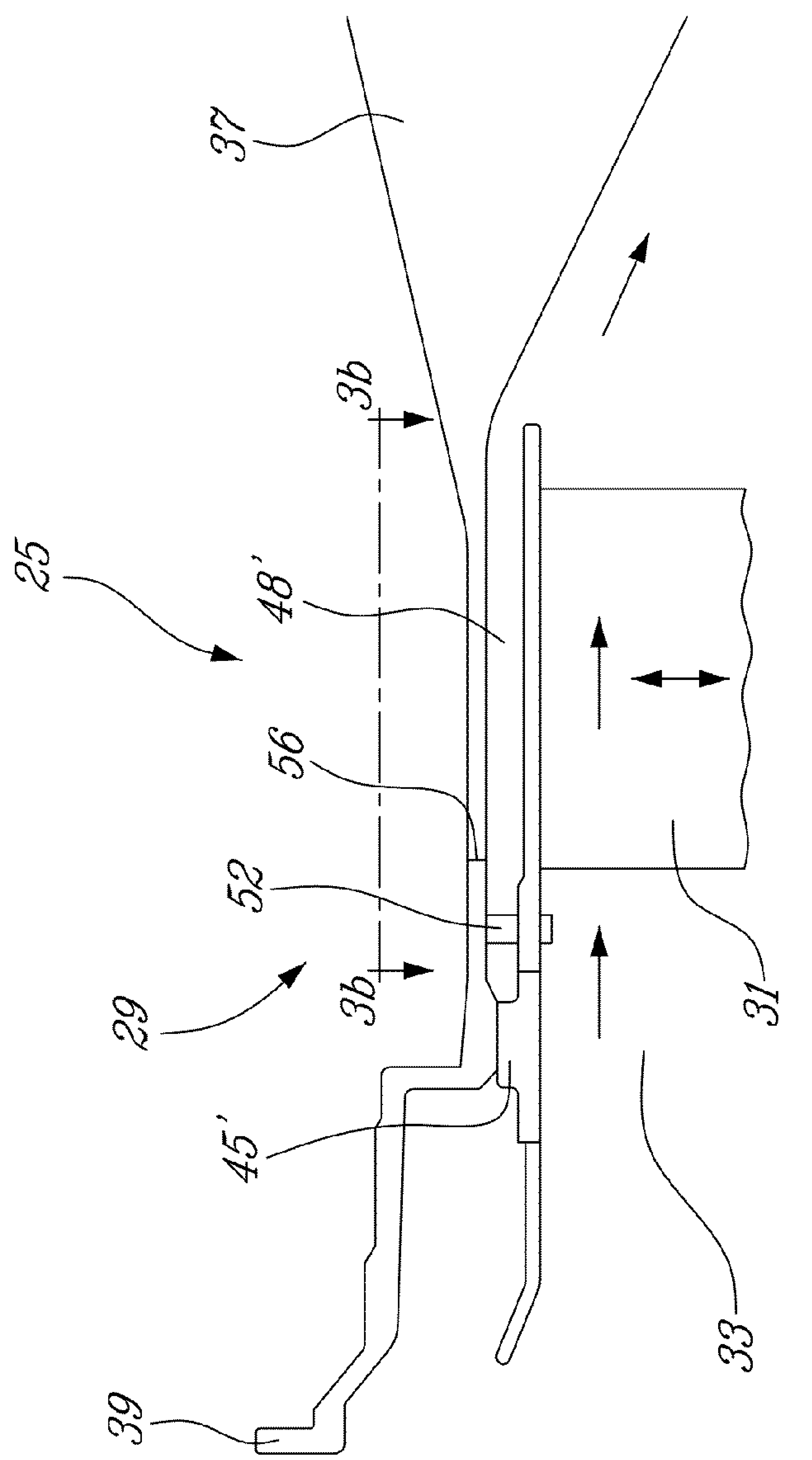

Fig-3a

STRUT MOUNTING ARRANGEMENT FOR GAS TURBINE EXHAUST CASE

TECHNICAL FIELD

The application relates generally to gas turbine engines and, more particularly, to gas turbine exhaust cases.

BACKGROUND OF THE ART

Turbine exhaust cases typically comprise inner and outer annular shrouds structurally interconnected by a plurality of circumferentially spaced-apart airfoils or struts. In use, the airfoils are exposed to the hot core flow leaving the turbine section and are, thus, subject to thermal expansion. Thermal fight or thermal mismatch between the inner and outer shrouds and the airfoils may result in non-negligible stress levels throughout the exhaust case structure. The thermal fight is amplified by the fact that the inner and outer shrouds tend to be cooler than the airfoils since they are somewhat thermally protected by the developed boundary layers and are also typically exposed to cooler external flows (e.g. fan bypass flow).

Over the years various approaches have been developed to reduce the level of stress in turbine exhaust cases. However, there remains room for improvement.

SUMMARY

In one aspect, there is provided a turbine exhaust case for a gas turbine engine having an axis, the turbine exhaust case comprising a radially outer annular shroud and a radially inner annular shroud concentrically mounted about said axis and defining therebetween an annular gaspath for channelling hot gases; at least one strut support ring mounted inside said annular gaspath adjacent to and spaced apart from an associated one of said radially outer and inner annular shrouds so as to define a radial gap with the associated one of said radially outer and inner annular shrouds, said at least one strut support ring having a plurality of circumferentially spaced-part axially projecting fingers; and a plurality of circumferentially spaced-apart struts extending radially between said inner and outer annular shrouds, said struts being mounted at a first radial end thereof to said axially projecting fingers of said at least one strut support ring, said axially projecting fingers being radially deflectable into said radial gap in response to a thermal growth of said struts.

In a second aspect, there is provided a turbine exhaust case of a gas turbine engine, comprising a radially inner annular shroud mounted about an axis, a radially outer annular shroud concentrically mounted about the radially inner shroud, the radially inner and outer annular shrouds defining therebetween an annular gaspath, a circumferential array of exhaust struts extending across the gaspath, at least one radial end of said exhaust struts being mounted on a flexible strut mounting structure, said flexible strut mounting structure being radially deflectable relative to said radially outer and inner shrouds to accommodate thermal expansion of said exhaust struts during engine operation.

DESCRIPTION OF THE DRAWINGS

Reference is now made to the accompanying figures, in which:

FIG. **1** is a schematic cross-section view of a turbofan gas turbine engine;

FIG. **2***a* is a schematic cross-section view of a turbine exhaust case of the engine shown in FIG. **1**;

FIG. **2***b* is a cross-section view taken along line **2***b*-**2***b* in FIG. **2***a;*

FIG. **3***a* is an enlarged cross-section view of the turbine exhaust case illustrating one possible flexible mounting arrangement of the exhaust struts to the outer shroud of the exhaust case; and

FIG. **3***b* is a cross-section view taken along line **3***b*-**3***b* in FIG. **3***a.*

DETAILED DESCRIPTION

FIG. **1** illustrates an example of a turbofan gas turbine engine generally comprising a housing or nacelle **10**; a low pressure spool assembly **12** including a fan **11**, a low pressure compressor **13** and a low pressure turbine **15**; a high pressure spool assembly **14** including a high pressure compressor **17**, and a high pressure turbine **19**; and a combustor **23** including fuel injecting means **21**.

Referring to FIGS. **1** to **3**, the gas turbine engine further comprises a turbine exhaust case **25** disposed immediately downstream of the last stage of low pressure turbine blades for receiving hot gases from the low pressure turbine **15** and exhausting the hot gases to the atmosphere. The turbine exhaust case **25** may comprise an annular inner shroud **27** (FIG. **2***a*) concentrically mounted about the central axis A (FIG. **1**) of the engine, an annular outer shroud **29** concentrically mounted about the central axis A of the engine and the inner shroud **27**. The inner and outer shrouds **27**, **29** define therebetween an annular gaspath **33** for channelling the engine core flow. A plurality of circumferentially spaced-apart struts **31** extends radially between the inner and outer shrouds **27**, **29** across the gaspath **33**. The struts **31** may not only serve as structural components, they may have an airfoil profile to serve as vanes for directing/straightening the incoming flow of hot gases. The struts **31** may also have a hollow body. A multi-lobed mixer **37** may extend axially rearwardly from the outer shroud **29**. A mounting flange **39** (FIGS. **2***a* and **3***a*) may be provided at the front end of the outer shroud **29** for securing the turbine exhaust case **25** to the engine case **41** (FIG. **1**) which, in turn, may be structurally connected to the nacelle **10** through a plurality struts **43** (FIG. **1**) extending radially through the bypass passage of the engine. Referring more specifically to FIG. **1**, it may also be appreciated that a tail cone **35** may be mounted to the aft end of the inner shroud **27** of the turbine exhaust case **25**. The tail cone **35** is bolted or other suitably removably connected to the inner shroud **27**.

In operation, combustion gases discharged from the combustor **23** power the high and low pressure turbines **19** and **15**, and are then exhausted into the annular hot gaspath **33** defined between the inner and outer shrouds **27**, **29** of the turbine exhaust case **25**. The tangential components included in the exhaust gases may be de-swirled by the struts **31** or similar de-swirling airfoil structures which may be integrated in the turbine exhaust case **25**, and then the exhaust gases are discharged into the atmosphere through the mixer **37** which facilitates the mixing of the exhaust gases with the outer air flow from the bypass passage.

Referring now more specifically to FIGS. **2***a* and **2***b*, it can be appreciated that the struts **31** may be mounted at an inner radial end thereof to a flexible strut mounting structure **40**. As will be seen hereinafter, the structure **40** provides thermal fight relief by providing a flexible mounting of the struts **31** to the exhaust case structure **25**. The flexible strut mounting structure **40** may comprise a circumferential array of generally axially extending springboard-like members or flexible fingers **42** adapted to be radially deflected in response of thermally induce movement of the struts **31**. According to the illustrated embodiment, the fingers **42** are defined in the aft end portion of a sheet metal support ring **44**. The support ring **44** is mounted inside the gaspath **33** adjacent to the inner shroud **27**. The support ring **44** is structurally connected at a forward end portion thereof to an enlarged diameter portion **46** of the inner shroud **27**. The support ring **44** may be mechanically fastened, such as by bolting, to the enlarged diameter portion **46** of the inner shroud **27**. As can be appreciated from FIG. **2***a*, the support ring **44** and, thus, the fingers **42** defined therein extend axially rearwardly in a cantilever fashion from the enlarged diameter portion **44** of the inner shroud **27**. The radial gap **48** between the fingers **42** and the inner shroud **27** allows accommodating the radial deflection of the fingers **42** in response to a thermal growth of the struts **31**.

According to the illustrated embodiment, each finger **42** supports one strut **31**. However, other configurations are contemplated as well. The struts **31** may be welded or otherwise suitably mounted on the fingers **42**. As can be seen from FIG. **2***b*, the axial length of the fingers **42** is selected so as to accommodate the full axial span or chord of the struts **31**. The fingers **42** may have an axially tapering profile from root to tip. The fingers **42** are slightly larger than the struts **31** in a circumferential direction. The space between adjacent fingers **42** is function of the distance between adjacent struts and of the desired finger flexibility. If an acoustic treatment is applied to the inner shroud **27**, the gaps between the fingers **42** may be made as large as possible in order to maximize the exposure of the acoustic treatment.

As shown in FIG. **2***a*, the acoustic treatment may comprise an acoustic panel **50**. More particularly, the inner shroud **27** may be composed of a single acoustic panel **50** or, alternatively, it can be circumferentially segmented and composed of a plurality of separate/individual arcuate acoustic panels **50** assembled into a circumferentially extending band. By forming the inner shroud **27** with acoustic panel(s) **50**, the acoustic treatment can be applied substantially along the full axial length of the inner shroud **27** that is from a forward end of the exhaust turbine case **25** to an aft end thereof, thereby providing added sound attenuation as compared to conventional arrangements where the acoustic treatment is applied downstream of the turbine exhaust case **25** to the tail cone **35** or in other non-ducted exhaust areas. The acoustic panels may consist of commercially available acoustic panels of the type having a sandwich structure comprising a core layer of cellular honeycomb like material disposed between two thin metal facing sheets or skins. The support ring **44** may be mounted directly to the forward end of the acoustic panel(s) **50**. The ring **44** extends axially rearwardly in an overlapping relationship with a portion of the panel(s). The support ring **42** may, thus, also act a frame member to hold the inner shroud acoustic panels **50** all together. The scallops that may be cut or otherwise suitably formed in the aft end of the support ring **44** to form the fingers **42** not only provide for a flexible mounting of the struts **31** but also allow to uncover the acoustic treatment which is underneath the support ring **42**.

As shown in FIG. **2***a*, the radially outer end of each strut **31** may be welded or otherwise suitably rigidly attached to the outer shroud **29**. However, as shown in FIGS. **3***a* and **3***b*, the struts **31** may be mounted at the radially outer end thereof to a second flexible mounting structure **40'** similar to structure **40** provided at the radially inner end of the struts **31**. The structure **40'** may comprise a support ring **44'** adapted to be axially fitted inside the outer shroud **29**. The support ring **44'** may be provided with an enlarged outer diameter at a forward end portion **45'** thereof to provide a tight circumferential fit between the outer shroud **29** and the support ring **44'**. Relative rotation between the outer shroud **29** and the support **44'** may be prevented by a male member **52** projecting radially inwardly from the outer shroud **29** into a mating catch or groove **54'** (FIG. **3***b*) defined in support ring **44'**. Other anti-rotation mechanism could be used as well. Like the inner strut support ring **44**, the outer strut support ring **44'** is provided with rearwardly projecting fingers **42'** defining a radial gap **48'** with the outer shroud **29**. The fingers **42'** have the ability of being deflected radially outwardly into the gap **48'** under the thermal expansion of the struts **31**. The struts **31** may be welded or otherwise suitably mounted to the fingers **42'**.

The mounting of the radially outer end of the struts **31** to an intermediate structure (namely the flexible mounting structure **40'**) as opposed to directly to the outer shroud **29** provides more flexibility for the designers in joining the mixer **37** to the remaining forward portion of the outer shroud **29**. Indeed, previously the junction of the struts **31** with the outer shroud **29** was somewhat interfering with the joining of the mixer **37** with the outer shroud **29** at an axial location corresponding to the area where the struts **31** were attached to the outer shroud **29**. Accordingly, the mixer **37** was typically attached to the outer shroud **29** at a location axially downstream of the struts **31**. Now that the radially outer end of the struts **31** are mounted to the fingers **42'** of the support ring **44'** inside the outer shroud **29**, the mixer **37** can be joined to the outer shroud **29** at a more axially forward location. According to the embodiment illustrated in FIG. **3***a*, the mixer **37** is welded to the outer shroud **29** at **56** in general alignment with the leading edge of the struts **31**.

The designers may also take advantage of the gaps/free space between circumferentially adjacent fingers **42'** to position thermocouples or other measuring instruments/sensors (not shown) in the gaspath **33**.

The above described inner and outer flexible strut mounting structures **40** and **40'** may be designed to maintain the integrity of the exhaust case **25** while providing just the right amount of flexibility to allow thermal expansion of the struts in a simple and practical way.

The above description is meant to be exemplary only, and one skilled in the art will recognize that changes may be made to the embodiments described without departing from the scope of the invention disclosed. For instance, it is understood that the flexible mounting structures may be provided at both ends of the struts or at only one of the radially outer and the radially inner end thereof. Also it is understood that individual cantilevered fingers could be separately mounted to an associated one of the inner and outer shroud. Still other modifications which fall within the scope of the present invention will be apparent to those skilled in the art, in light of a review of this disclosure, and such modifications are intended to fall within the scope of the appended claims.

What is claimed is:

1. A turbine exhaust case for a gas turbine engine having an axis, the turbine exhaust case comprising a radially outer annular shroud and a radially inner annular shroud concentrically mounted about said axis and defining therebetween an annular gaspath for channelling hot gases; at least one strut support ring mounted inside said annular gaspath adjacent to and spaced apart from an associated one of said radially outer annular shroud and said radially inner annular shroud so as to define a radial gap with the associated one of said radially outer annular shroud and said radially inner annular shroud, said at least one strut support ring having a plurality of circumferentially spaced-part axially projecting fingers; and a plurality of circumferentially spaced-apart struts extending radially between said radially inner annular shroud and said radially outer annular shroud, said struts being mounted at a first radial end thereof to said axially projecting fingers of said at least one strut support ring, said axially projecting fingers being radially deflectable into said radial gap in response to a thermal growth of said struts, said at least one strut support ring comprising a first strut support ring mounted to said radially outer annular shroud, wherein an anti-rotation mechanism is provided to retain the first strut support ring against angular movement relative to the radially outer annular shroud, said anti-rotation mechanism comprising at least on male member projecting radially inwardly from said radially outer annular shroud in engagement between two circumferentially adjacent fingers of the axially projecting fingers of the first strut support ring.

2. The turbine exhaust case defined in claim **1**, wherein said at least one strut support ring is supported in a cantilever fashion by said associated one of said radially inner annular shroud and said radially outer annular shroud.

3. The turbine exhaust case defined in claim **2**, wherein said at least one strut support ring is supported at only a forward end thereof, the axially projecting fingers being provided at an axially opposed aft end of the at least one support ring.

4. The turbine exhaust case defined in claim **1**, wherein said at least one strut support ring is a unitary sheet metal member.

5. The turbine exhaust case defined in claim **1**, wherein the struts have an axial length defined between a leading edge and a trailing edge of the struts, and wherein the axially projecting fingers have an axial length which is equal to or greater than the axial length of the struts.

6. The turbine exhaust case defined in claim **1**, wherein the fingers are spaced-apart by generally axially extending cuts, said cuts exposing an acoustic treatment applied to said associated one of said radially outer annular shroud and said radially inner annular shroud.

7. The turbine exhaust case defined in claim **1**, wherein each of said axially projecting fingers supports only one of said struts.

8. The turbine exhaust case defined in claim **1**, wherein said struts are structurally connected at a second radial end thereof to the other one of said associated one of said radially outer annular shroud and said radially inner annular shroud.

9. The turbine exhaust case defined in claim **1**, wherein said at least one strut support ring further comprises a second strut support ring supported at a forward end portion thereof by said radially inner annular shroud.

10. The turbine exhaust case defined in claim **1**, wherein said associated one of said radially inner annular shroud and said radially outer annular shroud is said radially inner annular shroud, said strut support ring being mechanically fastened at a forward end thereof to said radially inner annular shroud, said fingers projecting axially rearwardly of said forward end in overlapping relationship with an acoustic treatment applied to said radially inner annular shroud, the fingers being moveable towards and away from the acoustic treatment in response to thermally induced movement of the struts.

11. The turbine exhaust case defined in claim **1**, wherein said first strut support ring is circumferentially supported at a forward end thereof by said radially outer annular shroud.

* * * * *